

**A STUDY OF
PRIMARY REPAIR FOR THE TREATMENT
OF PENETRATING COLONIC INJURIES**

**THESIS
FOR
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(GENERAL SURGERY)**



**BUNDELKHAND UNIVERSITY
JHANSI (U. P.)**



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C E R T I F I C A T E

This is to certify that the work entitled
" A STUDY OF PRIMARY REPAIR FOR PENETRATING COLONIC
INJURIES." which is being submitted as THESIS for
M.S.(General Surgery) examination, 1992 of Bundelkhand
University, Jhansi. by Dr. SURET SINGH has been carried
out under my direct guidance and supervision. His
results and observations have been checked and verified
by me from time to time.

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I N D I A

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(SURET SINGH)

C O N T E N T S

Sl. No.	Particulars	Page No.
1.	INTRODUCTION ...	1 to 09
2.	REVIEW OF LITERATURE ...	10 to 20
3.	MATERIAL AND METHODS ...	21 to 23
4.	OBSERVATIONS ...	24 to 33
5.	DISCUSSION ...	34 to 39
6.	CONCLUSION ...	40 to 41
7.	BIBLIOGRAPHY ...	42 to 47
8.	SUMMARY ... (Attached Separately)	

INTRODUCTION

INTRODUCTION

Injuries of the colon may occur from a variety of mechanisms. Automobiles, guns, and knives are common etiologic agents. Injuries so produced usually occur in a normal colon filled with faeces. Such injuries are ordinarily lethal unless properly treated. The proper treatment of a traumatically injured colon has been the subject of considerable controversy. The traditional approach of exteriorization of the injured segment of colon continues to be advocated by many surgeons, where as others advocate primary closure of the injury in selected cases. Whatever method is utilized it should be remembered that death from the colon injury per se can almost always be avoided if the injury is treated in timely and proper fashion.

In addition to external trauma, the colon may be injured during various diagnostic and therapeutic procedures. Perforation during procto-sigmoidoscopy and colonoscopy with or without a concomitant polypectomy as well as perforations during barium enema, dilatation and curettage in females have all been reported. Although certain authors have argued for an individualised approach to each of these types of injury, others believe a standard approach should be used for all.

Wounds of the colon resulting from penetrating trauma are commonly encountered at hospitals throughout the country. Prior to world war II this type of injury was associated with significant mortality and morbidity. Since then important work has been done in this area and characteristics of anastomotic healing have been firmly established. Today these wounds should be viewed as a serious event, but one that can be easily and safely managed provided sound surgical principles are adhered to and the surgeon is aware of the preferred therapy for the specific injury pattern present.

The epidemiologic characteristics of colon injury patients confirm to other groups of trauma victims since most are young males injured in or near their place of residence. In urban environment the majority result either from gunshot or stab wound. Blunt trauma including motor vehicle, alheletic or iatrogenic accidents, occur less frequently. However, in rural community the ratio between blunt and penetrating trauma is likely to be reversed.

The colonic injury can either be solitary or multiple. Most solitary colon injuries result from a stab wound and they tend to be randomly distributed throughout the colon. The gunshot wounds commonly produce injuries to multiple site within

the colon as well as damage to other organs within peritoneal cavity. High velocity weapons cause massive destruction of internal organs and surrounding tissues. Low velocity bullets cause less damage on entering the body. They often lodge in the tissues and thus there may not be an exit wound. Bombs explosions may have a devastating effect on the abdominal wall and intra-abdominal organs.

The colon is commonly injured by penetrating abdominal trauma. In most contemporary series, the infectious morbidity rate ranges from 25 to 35 percent and the mortality rate range from 3 to 5 percent. Most of the infectious morbidity following abdominal injury occurs as a consequence of delayed diagnosis or inadequate therapy for colon injuries.

The colon is at particular risk of infection. Because of the bacterial content of the colon a relatively minor leakage of faeces in the peritoneal cavity may result in a large inoculum of pathogenic bacteria. Furthermore breakdown of the colonic sutureline is more common than that seen with other hollow viscus injuries. Hawley and associates have shown experimentally that there is a greater concentration of collagenase in the colon than elsewhere in the bowel. Cronin and Co-workers demonstrated a greater increase in collagenolytic activity in the colonic wall after injuries than after colonic anastomosis. Penicillinase and penicillamine are

produced in variable concentrations by the colonic bacteria and could contribute to the weakening of cross-linking of collagen, which is necessary for the healing of anastomoses.

It is generally agreed that early recognition of colon injuries is crucial in diminishing infectious morbidity and mortality. A recent report has shown no mortality and an eleven (11%) percent infection rate in colon wounds diagnosed and treated within 2 hours of injuries. In addition to early recognition and treatment, the early administration of prophylactic antibiotics is beneficial in minimizing infectious morbidity and mortality.

Patients with perforating wounds of the colon present a special challenge to the clinical judgement of the surgeon. Excessive morbidity is caused by disruption of the suture line in the intestine, abdominal abscess, wound infection, unnecessary colostomy and repeated hospitalisation. These untoward consequences of trauma to the colon can be reduced by careful assessment and individualised therapy for each patient.

Experience gained during military conflicts resulted in substantial improvements in the morbidity and mortality of colonic wounds. During world war I, primary closure of the colon injury resulted in 60 percent

mortality. During world war II the routine use of exteriorisation drastically reduced the mortality of colonic wounds. The continued use of exteriorisation and the improvement in method of triage and transportation, surgical intervention and widespread use of antibiotics further reduced the mortality of colon wounds to 15% during Korean war and to 12% during the Veitnam conflict.

Though Imes suggested primary repair of injuries to the colon as early as 1945, widespread use of colostomy was prevailing method in most civilian centres. Primary closure was not advocated on a large scale until 1970, when Be all and associates reported a series of primary repairs of the colon with results comparable to colostomy. The technique had the advantage of obviating secondary and tertiary procedures. Most recently treatment of the injured colon by exteriorized primary repair with early "interiorization" during the same hospitalization has been suggested. These two approaches, primary closure and exteriorized closure, have lead to abandonment of dogmatic approach of 'colostomy only' as the only acceptable method of management of colonic injuries.

Controversy still abounds in the management of civilian colonic injuries. Primary repair, exteriorisation and colostomy have all been advocated as the primary modality of treatment in managing wounds of the colon.

To complicate matters further, the type and magnitude of associated injuries also play significant role in the outcome of the repair and must be taken into consideration when selecting the modality of repair. Primary repair of the colon can be risky and ill advised in many situations whereas colostomy may be unnecessary in other circumstances. In addition although colostomy may be safe initially, it is attendant with a larger hospital stay and other risks at the time of closure.

Recent practice for management of colon injuries which has tended to incorporate principles gleaned from military experiences includes.

1. PRIMARY SUTURE OR STAPLE CLOSURE :

This technique is utilized primarily for right colon injuries and for relatively clean wounds of the left colon.

2. EXTERIORIZATION AND/OR PROXIMAL COLOSTOMY:

If the injury has occurred in mobile portion of the colon, it is exteriorized as a colostomy. Otherwise the injury is repaired by suture and a proximal diverting colostomy is performed.

3. EXTERIORIZED PRIMARY REPAIR :

The injured colon is sutured closed and the injury is exteriorized as an unopened colostomy. After 3 to 10 days the injured colon is replaced into the abdomen. If the repair breakdown, the exteriorized

colon functions as colostomy. This technique has fervent advocates but it is not recommended with any enthusiasm.

4. PRIMARY RESECTION WITH ANASTOMOSIS :

Extensive lesions of the right colon and occasional injuries of the left colon may be managed by resection and anastomosis.

In a military setting, heavy reliance on 'Proximal colostomy or exteriorization is appropriate, but in recent years it has been recognised that civilian trauma to the colon may be managed in more selective manner, which includes primary suture.

Till recently the management of colon injuries was either exteriorisation of injured colon or repair of colonic injury plus proximal colostomy. It was repeatedly observed that a tear in small intestine when sutured healed nicely primarily but if the tear in the colon was closed primarily without proximal colostomy the tear did not heal properly and incidence of leakage through the sutured tear was very high.

The reasons were thought to be as follows :

1. Poor blood supply of colon as compared to small intestine.
2. Heavy bacterial content in colon which caused lot of gas formation, resulting in leakage through sutured tear.

3. Another very important reason was closed loop construction of colon.

Colon is a closed loop, ileocaecal valve at the proximal end and anal canal with its double sphincters at the distal end acting as air tight valves not allowing even gas to pass out of colon involuntarily. Thus after closure of colonic tear when there is gas formation inside colon, due to heavy bacterial content, this gas does not escape outside colon and it escapes through sutured tear causing a leak. The proximal colostomy was used as it acted as safety valve allowing gas to escape, thus allowing healing of tear to occur.

But recently due to many advances in management primary repair of colonic tears is being undertaken without proximal colostomy or exteriorization successfully. The recent introduction of combination of antibiotics- Ampicillin for Gram positive bacteria, Gentamycin for Gram negative bacteria and Metronidazole for anaerobic bacteria, reduces bacterial flora of colon effectively. Although given parenterally these antibiotics reach the colon through enterogenous secretion in intestinal juices and sterilise the colon. The escape of gas is facilitated either by anal dilatation at the time of operation, making the anal sphincter incompetent or still better by passing flatus tube into the rectum through anal canal and suturing it to perianal area and leaving it there for one week, so that any gas formed into colon or rectum can come out

through the tube and does not distend the colon. If the tear is in descending or sigmoid colon, a further safety step is taken by passing a long Ryle's tube from anal canal past the sutured colonic tear into descending or sigmoid colon and irrigating the colon with injection Kanamycin and Metronidazole twice daily. This not only further, reduces bacterial content of the colon but also allows any gas formed to escape through the tube. The tube is left for one week in the colon.

This management is being used at present to tackle all injuries to colon.

REVIEW OF LITERATURE

Historically the mandate that colostomy is the only proper treatment for colonic injuries may be traced to a 1943 united states army communication. This study was reinforced by studies generated near the end of world war II. Most important of these studies was by Ogilvie 1944, who reported from England in a review of the experiences of Surgeons in the Western desert during the North African campaign. Mandatory colostomy was considered to be the only treatment for the colonic injuries. This recommendation included bruises of the colon, possible injuries to the posterior portions of the colon i.e. the retroperitoneal areas.

The United states army also moved to solidify the place of colostomy as the only proper means to treat a colonic injury. Ma Son JM in 1945 reviewed methods by which colonic injuries could be exteriorised. He dismissed the question of how to treat colon injuries by stating that " colon wounds among battle casualties." The statement is usually dismissed with the dictum. " Exteriorize all colon wounds."

This attitude remained through both the Korean & Veitnam conflicts. No dissenting voices were heard from these two arenas. The previous techniques were followed with no further studies emerging from the military experience. The introduction of antibiotics and development of rapid evacuation system

during the Veitnam conflict were not explored with respect to their impact on colonic injuries. Military surgeons continued to practice the methods established 25 years previously. Civilian trauma experience finally called into question the necessity of colostomy in the management of all colonic injuries. During world War I, primary closure of the colon resulted in a 60% mortality. During world war II the routine use of exteriorization drastically reduced the mortality of colonic wounds. The continued use of exteriorization and the improvements in methods of triage and transporation, surgical intervention and widespread use of antibiotics further reduced the mortality of colon wounds to 15% during Korean war and to 12% during Veitnam conflict.

Woodhall & Oschner in 1951 suggested primary repair or resection of perforating colon injuries. Thompson & Others reported that in the subsequent decade sufficient experience had been accumulated to suggest that certain colon injuries can be safely managed in such a manner thus avoiding colostomy. The high morbidity rate associated with colostomy closure as well as patient inconvenience, make avoidance of colostomy desirable. The problem then was to indentify those patients who might safely be managed by primary repair. Criteria of primary repair which were agreed upon were :

- 1- An interval of less than six hours since injury.

- 2- A small clean wound with little surrounding tissue damage,
- 3- minimal fecal contamination,
- 4- fewer than two associated injuries,
- 5- Absence of shock and
- 6- An otherwise stable patient.

It was suggested that primary repair and resection should be restricted to the right colon or at least be applied to the left colon only under more strict conditions.

It is not clear however that right colon injuries behave more favourably than those of the left colon. The argument that right colon injuries behave more favourably than left colon injuries has been based theoretically on the known anatomic and physiological difference between the right and left colon. The right colon functions physiologically to absorb and dehydrate the small intestinal effluent while the left colon is primarily for storage. Thus the right colon contents are liquid and the left colon contents are more solid. The wall of the right colon is thinner than that of left and lumen larger. There appears to be a higher concentration of bacteria in the left colon than in the right colon.

Hunt et al in 1970 postulated that healing of anastomosis is related to collagen content and

demonstrated increased collagenase activity in the left colon as compared to the right which may lead to a collagen deficit at the anastomotic site. The fate of exteriorized anastomoses however does not appear to be influenced by colonic location (Kirkpatrick JR 1977). Such evidence may be misleading because a larger number of anastomotic dehiscences can be identified that do not become clinically detectable sequelae of anastomotic disruption. The morbidity and mortality rates of elective colon resection on prepared bowel are similar in the right and left colon.

Schrock et al 1972 found no significant difference in anastomotic leakage with ileocolic, colocolic and left colo-colic anastomoses under elective circumstances and this has been confirmed by others (Hedburg SE, 1963). Irvin JJ & Golighar (1973) also found that proximal decompression didn't diminish anastomotic complications. Thus under elective conditions there appears to be no significant advantage of proximal decompression.

During surgery for trauma on the unprepared colon, fecal contamination may be an important factor in anastomotic healing. The degree of fecal contamination and its significance are difficult to assess however, because intraperitoneal haemorrhage is often present and the use of systemic antibiotics and lavage of the peritoneal cavity are often employed.

Further more Motolo et al 1976 found in the experimental models that anastomotic leakage was not influenced by the presence of even massive fecal contamination.

Garrison et al 1979 found that ileostomy did not decrease the mortality rate of right colon injuries. Thus, the significance of fecal contamination is not clear. A higher rate of anastomotic complications has been found in emergency left colon resections (Schrock TR et al 1962) but other have found the morbidity and mortality rates of right and left colon emergency resections to be similar.

Bartzial et al 1974 found the morbidity and mortality rates of right and left colon resection for penetrating injuries to be similar with similar operative management.

Multherin & Sawyears (1975) reported that primary repair of left colon injury was associated with fewer anastomotic leaks than right colon injuries, although primary repair was used more liberally in the right colon.

Primary closure was not advocated on large scale until 1970 when Beall & associates reported a series of primary repairs of the colon with results comparable to colostomy. This technique had the advantages of obviating secondary and tertiary procedures.

In contrast Schrock & Christensen in 1972

reviewed their experiences with primary closure with exteriorization of sutured perforation at San Francisco General Hospital. Only 4 of 19 exteriorized suture lines healed and 15 (79%) required conversion to loop colostomy. Eleven required colostomy because of leakage and 4 required colostomy because the exteriorized loop obstructed the colon. These untoward consequences of trauma can be reduced by careful assessment and individualised therapy for each patient.

Several clinical features were found to be correlated with poor results after treatment of trauma to the colon. These included the age of patient, the type of wounding agent, haematoma adjacent to perforation and undue delay from the time of injury to that of operation. Also associated injuries, shock and fecal contamination reflected over-all trauma as well as local conditions in the colon and had a correlation with morbidity and mortality.

Garfinkle SE et al in 1974 studied a series of 94 civilian colonic injuries, modes of treatment were variable ranging from double-barreled colostomy to primary repair with or without exteriorization. The data from the series do not support the dogmatic approach of "colostomy only" as the only acceptable method of management of colonic injuries. Primary repair with or without exteriorization in selected cases reduces morbidity, length of hospitalisation and the necessity of secondary operations. In these Ninety four patients studied during

studied during seven-years period the ages ranged from 6 to 78 years. Complications related to primary procedures occurred in 29% cases. The incidence in primary closure group was 25.5% as compared to 32% in patients treated with colostomies. In addition for those patients having colostomies there was a further complication rate of 22% associated with closure of colostomy including colocutaneous fistula, bowel obstruction, wound infection and colonic bleeding. Mortality associated with the management was 13% out of these 4% occurred in primary closure group and 21% in the colostomy group.

John R. Kirk Patrick in 1977 studied injuries of the colon and indicated that the surgeon should remember that primary closure is a safe and reliable method of management when careful patients selection is employed and the closure with exteriorization of the injured colon is a valuable adjunct that will significantly decrease the colostomy rate. However injuries of the sigmoid colon continues to require proximal colostomy, closure of the intestinal injury and wide pelvic drainage. Meticulous attention to the associated organ injuries is essential and the surgeon must be aware that the management of these associated injuries largely determines the survival.

Flint et al in 1978 reviewed Missile tract infections and indicated that these septic complications may be a major contributor to the intra abdominal

infections seen in relation to penetrating trauma.

If the infections are cause of some of the complications seen then colostomy formations could not be expected to prevant them.

Stone & Fabian in 1979 carried out a prospective randomised non-blind study with 268 patients. Considerations of primary closure demanded that pre-operative shock was never profound, blood loss was less than 20% of the estimated normal volume, no more than two intra abdominal organ systems were injured, fecal contamination was minimal, surgery was begun within 8 hours of injury and the wounds of the colon were technically amenable to closure. Comparison of these patients meeting these criteria and having a primary closure and those treated by more traditional means showed no statistical difference

Sister Mary AnnLou et al in 1981 reported on exteriorized repair in the management of colon injuries also known as primary repair and exteriorization of the injured colonic segment. In 66% patients the colonic wounds successfully healed and the exteriorized loop returned into the peritoneal cavity within 14 dyas. In 34% cases faecal leakage developed at the repair site and the exteriorised loop were converted into colostomes without sepsis. There was no mortality and a low complication rate (18%). They concluded that exteriorized

repair is extremely safe, as it obviates the morbidity of mandatory colostomy yet avoids the risks of primary repair alone.

Flint LM et al in 1981 classified colonic injuries intra-operatively and advocated management accordingly.

- GRADE I. Isolated injury, minimal contamination, no shock, minimal delay, Occurance 16%.
- GRADE II. Through and through perforation, laceration, moderate contamination. Occurance 74%.
- GRADE III. Secure tissue loss, devascularisation, heavy contamination. Occurance 10%. They advocated management as :-

Grade I : Single layer primary closure.

Grade II and III by colostomy or exteriorization.

Chan V Dang et al in 1981 reported about management of trauma of colon. 82 colonic injury cases were reviewed to determine the indications for primary repair or colostomy and to assess the feasibility of early drop-back of exteriorized repaired colon.

They graded injuries into three stages :

- Stage I : Good risk
- Stage 2 : Moderate risk
- Stage 3 : Badrisk

They indicated that primary repair is good for stage I injuries.

Exteriorized repair with early drop-back is safe and economical for most patients with stage 2, injuries and selected patients with stage 3 injuries.

Nallathambi MN et al in 1984 published their report on aggressive Definitive management of penetrating colonic injuries and concluded that majority of the right colon injuries can be treated definitively i.e. by primary repair. Exceptions are prolonged time interval before operation and established peritonitis during laprotomy. In selected low risk patients with left colon injuries, primary repair is effective. Whenever colostomy is considered in right or left colon injuries, exteriorized repair should be preferred method, colostomy should be reserved for serious left colon injuries requiring resection.

D. Denetriados et al in 1985 reported about the management of the colonic injuries by primary repair or colostomy that primary repair can safely be performed more frequently than is generally accepted. The site of colon injuries, the presence of shock and presence of multiple associated intra-abdominal injuries donot exclude primary repair. It was suggested that colostomy should be reserved for those left and right colon injuries with gross peritoneal contamination, extensive colonic damage and large amount of hard faeces in the colon. Their retrospective study comparised of 134 cases of penetrating colonic injuries. In 92 cases

the injury involved left colon and in remaining 42 the right colon. Death due to the colonic injury occurred in 1.5% and the incidence of abdominal complications was 17.9%. Patients treated by primary repair of the colon had less colon related complications and a shorter hospital stay than the patients treated with colostomy. Left and right colon injuries treated by primary repair had similar complications rate and hospital stay.

Redgeway CA et al in 1989 found in their studies that colostomy was not mandated by anatomic location or number of colonic injuries, circumference of colonic wall involved, presence of faecal contamination, or involvement of blood supply. This study indicated that primary repair does not carry increased risk of septic complications and saves the patient risk and increased stay of colostomy closure.

MATERIAL AND METHODS

MATERIAL AND METHODS

During one year period from May' 1990 to May 1991 Fourteen patients were treated by primary repair for penetrating colon injuries at Maharani Laxmi Bai Medical College and Hospital, Jhansi (U.P.) India.

All patients admitted with penetrating colonic injuries who were treated by primary repair were included in the study. There were 11 men and 3 women. Their ages ranged 17 to 55 years. The mode of injuries were : Gunshot wounds (7), Stab wounds (4), blast injuries (1) and iatrogenic wounds (2).

The emergency room treatment protocol consisted of resuscitation and aggressive restoration of volume deficit with balanced salt solution and type-specific crossmatched blood in hypotensive patients. A combination of antibiotics- Ampicillin, Gentamycin and Metronidazole were administered intravenously to all patients with penetrating abdominal trauma. Decision to perform laparotomy was made on clinical grounds in most of the patients and in few cases of stab wounds with equivocal abdominal signs, peritoneal lavage was used. Skiagram abdomen (erect view) were taken.

Operation was begun as soon as possible and the mean time interval between arrival to emergency room and operation was 4 hours. Two third of the patients were in the operation room within 3 hours of arrival.

Intraoperatively, after control of haemorrhage colon injuries were assessed for their location, extent of damage and degree of faecal contamination. The associated organ injuries were also properly assessed and treated. In all the cases primary repair of colon perforation (s) in one layer after debridement of devitalised tissue was done. colon resection was performed when the injury was extensive and/or when the vascularity of the segment was compromised. In all cases peritoneal lavage was done with metronidazole and normal saline. In infected cases betadine was also added for peritoneal lavage. In four cases anal dilatation was done at the time of operation making the anal sphincter incompetent; In five cases a flatus tube was passed and stitched to perianal areas leaving it there for one week. In five cases a Ryle's tube from anal canal past the sutured colonic tear into descending/ sigmoid colon was used.

Post-operatively combination of antibiotics Ampicillin, Gentamycin/Kanamycin and Metronidazole was used in all cases & was continued for 5 to 7 days. Faecal

Faecal matter coming out of Ryle's tube (put through anus) or flatus tube was cultured for aerobic and anaerobic bacteria. Irrigation with Kannamycin and Metronidazole was done and difference in bacterial content noted.

OBSERVATIONS

PATIENTS :

There were total 14 patients of penetrating colonic injuries out of which 11 were men and 3 were women with ages ranging from 17 to 55 years (Table I).

TABLE - I

Showing Age and Sex distribution of penetrating colonic injuries.

S.No.	Age (Years)	Number of patients		Percentage of total patients	
		Male	Female	Male	Female
1.	15 to 20	6	-	42.85	-
2.	21 to 40	5	2	35.71	14.28
3.	41 to 60	-	1	-	7.14

This table shows that the maximum percentage of patients were males and among the males also maximum number of patients were from 15 to 20 years in age (42.85%). Next male age group of patients was 21 to 40 years (35.71%) i.e. the age groups vulnerable to criminal activities.

Among the females maximum number of patients were in the age group 21 to 40 years (14.28% of total patients and 66% of female patients).

There was no patient of paediatric age group.

WEAPON CAUSING PENETRATING INJURY :

Table 2 shows frequency of weapon used which caused penetrating colonic injury.

TABLE -2

Showing weapon used causing penetrating colonic injury:

Mechanism	Number of cases	Percentage
Gun shot wound	7	50.00%
Stab wound	4	28.57%
Blast wound	1	7.14%
Iatrogenic wound (during MTP)	2	14.28%

The table shows that maximum number of patients sustained colonic injuries with Gun-shot (50.00%). Next commonly used weapon was a sharp weapon causing stab wound (28.57%). In the series, two patients (14.28%) suffered iatrogenic injuries of the colon during dilatation and curettage (D & c) for Medical termination of Pregnancy (M.T.P.), one patient (7.14%) suffered with blast injury.

Patients reached Medical college hospital from 45 minutes to two days after injury.

CLINICAL CONDITION ON ADMISSION :

Seven patients (50.00%) were admitted in state of shock (B P systolic 90 mm Hg)

SITE OF COLONIC INJURY :

Table 3 shows site of colonic injury.

TABLE - 3

Showing distribution of penetrating injuries of the colon

Site	No. of Patients	Percentage
Caecum	2	14.28
Ascending colon	2	14.28
Transverse colon	2	14.28
Descending colon	4	28.57
Sigmoid colon	2	14.28
Multiple segments	2	14.28

Out of 14 patients, site of injury was caecum in two (14.28%), Ascending colon in two (14.28%), Transverse colon in two (14.28%), Descending colon in four (28.57%) and sigmoid colon in 2 (14.28%). In two patients (14.28%) multiple segments of colon were involved. Distribution of injury to right and left colon was equal.

ASSOCIATED INJURIES :

Table 4 and 5 shows associated injuries in Eleven patients i.e. associated non-colonic intra-abdominal injuries.

TABLE - 4

Showing associated injuries in patients with penetrating colonic injuries.

ORGAN	No. OF PATIENTS
Stomach	Two
Small Intestine	Seven
Mesentary	one
Liver	one
Spleen	one
Kidney	one
Uterus	Two

Out of total 14 patients of penetrating colonic injuries eleven (78.57%) had associated non-colonic intra-abdominal injury. In these eleven patients small intestine was commonly involved.

Various injury combinations of colon and non-colonic intra-abdominal organs are shown in table5 .

TABLE - 5

Showing distribution of various injury combinations in 14 patients.

Pattern of Injury	Number of patients	Percentage
1. Colon alone	3	21.42
2. Colon + 1 organ	7	50.00
a. Small Intestine	5	
b. Uterus	2	
3. Colon + 2 Organ	4	28.57
a. Jejunum+stomach	1	
b. Spleen +Left Kidney	1	
c. Stomach+Liver	1	
d. Ileum +Mesentary	1	

Out of 14 patients seven patients (50.00%) had associated injury of one organ only, four patients (28.57%) had associated injury of two organs. In single organ associated injuries in 5 cases it was small intestine and two cases it was uterus. In two organs associated injuries various combinations were, Jejunum and stomach, spleen and left kidney, stomach and liver, Ileum and mesentary.

OPERATIVE MANAGEMENT :

The operative management of colon injuries according to mechanism of injury is shown in table 6.

Table - 6

Showing treatment method according to mechanism of injury :

Treatment Method	Stab wounds	Gun shot wounds	Blast wounds	Iatrogenic wounds
Primary Repair by suturing	2	6	1	1
Primary repair by resection and anastomosis	2	1	-	1

Out of total 14 patients in 10 patients (71.40%) colonic injury was repaired by primary suturing of the perforations and in 4 patients (28.57%) primary repair was done by resection of devitalised tissue and anastomosis and colon was returned to peritoneal cavity primarily i.e. exteriorization was done in none of the patients.

INVESTIGATIONS :

Culture of Faecal matter coming out of Ryle's tube (put per anum) or flatus tube.

Various Organisms grown on aerobic and anaerobic culture were :

1. E. Coli
2. Staphylococcus aureus

3. Pseudomonas
4. Klebsiella
5. Clostridium welchii.
6. Clostridium tetani.

Their concentration was considerably reduced after irrigation of colon through flatus tube with Metronidazole & Kanamycin.

SKIAGRAMS :

Plain skiagram abdomen (erect view) showed gas under diaphragm in cases where skiagram was taken. In some cases due to urgency of operation and non-availability of X-ray facility at night skiagram could not be taken.

MORTALITY :

There were two deaths (14.28%), both of them died due to severe associated injuries. Colon related death occurred in none of the patients. One patient who died had splenic rupture and mutilated left kidney. He came with shock, there was diminished air entry at both bases. Splenectomy with left nephrectomy was done along with resection and end-to-end anastomosis of descending colon. This patient died 7 hours after operation.

Second patient who died had severe shock. He presented in condition when his blood pressure and pulse were not recordable. There was severe pallor, patient

was dehydrated and comatose. Patient never recovered from shock and died of shock and cardiorespiratory arrest.

MORBIDITY :

Table 7 shows major complications among the survivors.

TABLE - 7

Showing major complications among survivors.

Complications	Number of patients	Percentage
I. Sepsis.		
(a) Wound infection	1	7.14
(b) Anastomotic leak	2	14.28
II. Wound dehiscence	1	7.14

Overall there were complications in two patients related to colon (14.28%). Out of these two patients one had anastomotic leak, wound of entry (gun-shot) infected and same patient had wound dehiscence. Second patient had anastomotic leak. So overall infection rate of wound of entry was 1/14 (7.14%), wound dehiscence was 1/14 (7.14%) and anastomotic leak in 2/14 (14.28%) patients. Both these patients who had complications were injured by gun-shot. So complication rate was more in gunshot wound as compared to stab wounds. In one of these patients ascending colon was injured and in the second descending colon was injured. So complication

rate was equal in right and left colon. Both the patients who developed complications had undergone primary repair by resection and anastomosis. None of the patients undergoing primary repair (not requiring resection anastomosis) had any complications.

In seven patients (50%), the degree of peritoneal contamination was found. Gross contamination was found an important factor in the development of abdominal complications. There were 3 patients with gross contamination and two of them (66%) developed complication (2 anastomotic leaks, one wound dehiscence and one infection at site of entry wound). Out of four patients with no gross contamination none developed complications.

It seems that the presence of shock at the time of admission does not affect the incidence of colon related complications irrespective of form of treatment. There were seven patients who presented with shock. All of them were treated by primary closure or primary repair by resection and anastomosis but none of them had any complications.

The presence of more than one associated intra-abdominal injuries was not found to be a risk factor in the development of colon-related complications. None of the two patients who had complications had more than one associated injuries.

HOSPITALIZATION :

The average stay of patients (Survivors) treated by primary closure was two weeks. Left or right sided location of colonic injury, mode of injury didnot influence the duration of hospital stay, provided the treatment method was the same.

Average stay of fatal cases was less than 24 hours.

DISCUSSION

The present study was conducted on fourteen patients of penetrating colonic injury who were admitted in Maharani Laxmi Bai Medical College & Hospital, Jhansi (U.P.) India and were treated by primary repair.

It is generally believed that right and left colonic injuries should be treated differently. Most authors suggest that primary repair or resection and anastomosis is safe in the majority of right colon civilian injuries, while they have strict criteria for primary repair in the left colon. Some authors even recommended routine colostomy in all left colon injuries. This approach to the injured colon is based on theoretical grounds rather than on clinical evidence; however there is no clinical evidence to show that right and left colonic injuries behave differently. Thompson et al found the same morbidity in right and left colonic injuries in two similar groups with respect to various complication risk factors. Dang et al and Bartzial et al reported similar results. In the present study injuries of the right colon had a similar morbidity as the left colon. Injuries of the right colon treated by primary repair had the same morbidity as the ones in the left colon treated similarly.

Most authors recommended primary repair of the colonic injuries, especially the left, only under strict criteria; minimal tissue damage, minimal faecal contamination, less than two associated intra-abdominal injuries, and no shock on admission. Shock on admission is generally considered a contra-indication to primary repair, especially in left colon injuries. The findings of present study do not support this view; the incidence of colon related complications in shock and normotensive patients was same irrespective of location of injury and modality of treatment. Similar results were reported by Shannon et al.

Most authors advise against primary repair, especially in the left colon in the presence of more than two associated intra-abdominal injuries. Our findings do not support this ; the presence of associated intra-abdominal injuries was not associated with higher incidence of colon related abdominal complications irrespective of the modality of treatment.

It seems that the most important risk factor for the development of abdominal complications is the gross contamination at the time of operation. In our opinion under such circumstances a colostomy should be performed irrespective of right or left sided location of the injury. Some authors suggest that primary repair

or anastomosis can safely be performed in right colon injuries, even at the presence of gross contamination. The findings in the present study do not support this view.

Our incidence of wound sepsis was low (14.28%) despite the fact that we routinely performed primary closure of the skin and subcutaneous tissue. This compares favourably with other series where the wound was left open. Our low infection rate was probably due to the pre-operative administration of antibiotics and the washing of the wound with normal saline, Metronidazole and Betadine before closing the abdomen.

Generally colostomy is considered as the safest method of treatment of colonic injury. Although this may be true for certain injuries where suture line leak is likely, we believe that colostomy has been over used. A colostomy is an open source of contamination very close to an incision and with a possible communication with the abdominal cavity through its abdominal wall exit. Theoretically it should be associated with a higher incidence of wound sepsis and intra-peritoneal abscesses. Further more it is associated with longer hospital stay than after primary repair and the patients have to be subjected to the inconvenience and risks of another operation for colostomy closure, a procedure with significant morbidity. We believe that the clinical significance of the different anatomy, physiology and bacteriology of right and left colon has been over emphasized. Our findings suggest that both sides of the colon behave similarly after injury. In most cases

primary repair could safely be performed in both right and left colons. Indications for colostomy should be gross peritoneal contamination, major colonic injuries, and the presence of a large amount of hard faeces. The presence of shock on admission and multiple associated injuries should not be contra-indications for primary repair.

Previously it was seen that in 1943 (II world war) the lesson learned was that primary repair of colonic injuries was associated with the high degree of leakage. The reasons thought to be responsible, for this were (1) Poor blood supply of colon, compared to small intestine. (2) High bacterical content of colon.

A very significant factor which can be added in retrospect to this is closed loop characteristic of colon. At the proximal end, a competent ileocaecal valve does not allow even air to pass from colon to terminal ileum. At the distal end, anal canal is tightly closed by two sphincters (internal and external) and normally does not allow even air to pass. The high bacterial content of colon causes fermentation of colonic contents with gas formation. This gas can neither pass in ileum nor outside thus causing distension of colon and leaking through the anastomosis. Therefore previously colostomy was advised after primary suture of injured area of colon so that the gas formed in the colon could come out through colostomy and could not damage the suture line. The success of primary closure of colonic injuries

attributed to successful management of this problem. The bacterial content of the colon was reduced in two ways.

1. By giving parenteral antibiotics-

Ampicillin for Gram positive, Gentamycin for Gram-negative and Metronidazole for anaerobic bacteria.

Due to internal enteric circulation, all these antibacterial drugs reach in enteric and colonic secretions also and sterilise the gut.

2. By direct instillation of antibiotics-

Kanamycin and Metronidazole into the colon by passing a long Rule's tube through anus into the colon. If injury was on left side of colon, this tube was passed and guided proximal to colonic anastomosis and fixed to perianal region. Even if injury was on right side this tube was passed as high into colon as possible and fixed to perianal area and kept there for one week. Installation of Inj. Kanamycin half gram and Metronidazole 250 mg was done twice a day after raising the foot end of bed for half an hour so that these antibacterials could reach and be retained as high as possible in the colon. This markedly diminished bacterial content of colon and thus gas formation.

The closed loop character of the colon was disrupted and instant passage of flatus and faeces was

assured by passing a thick-bore flatus tube through anal canal into rectum and fixing it to perianal area. This tube was left for one week into the rectum, so that any gas and faecal matter formed inside colon could immediately come out through this tube and thus not distend the colon and disrupt the anastomoses. We believe that this triple management has been responsible for very low incidence of leakage in our series, which was till now the vane of primary colonic suture.

conclusion

The present study was conducted on fourteen patients of penetrating colonic injuries who were admitted in Maharani Laxmi Bai Medical College, Hospital, Jhansi (U.P.) India from May' 1990 to May 1991.

Injuries to the colon due to penetrating trauma as well as iatrogenic causes are common and are quite lethal unless properly treated. The study presented here clearly demonstrates that treatment of colonic injuries based on early diagnosis, pre-operative and post-operative systemic anti-biotics, lavage of peritoneal cavity with Metronidazole, Betadine and saline solution and post-operative instillation of antibiotics locally in the colon with avenue to pass flatus and faecal matter as soon as formed through a flatus tube in anal canal can result in success with primary suture of colonic injuries without any need for defunctioning colostomy.

Primary repair of penetrating colonic injury was done either as such as in cases where loss of colonic tissue was minimal and there was no impairment of blood supply of injured part or primary repair was done by resection and anastomosis, in cases where part of colon was devitalised or its blood supply was compromised.

Involvement of the right and left colon was equal. Death due to colonic injuries occurred in none of the patients and the incidence of abdominal complications was minimal, two out of fourteen patients (14.28%). Complications were in form of wound dehiscence, wound sepsis and faecal fistula. Patients treated with primary repair of the colon had less colon-related complications and a shorter duration of hospital stay than patients treated by colostomy previously. Left and right colonic injuries treated by primary repair had similar outcome and hospital stay. We believe that primary repair can safely be performed more frequently than is generally accepted. The site of colon injury, the presence of shock and the presence of multiple associated intra-abdominal injuries do not exclude primary repair. It is suggested that colostomy should be reserved for both left and right colon injuries with gross peritoneal contamination, extensive colonic damage and large amount of hard faeces in the colon.

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